

## Taxonomical Studies on Tintinnids (Protozoa: Ciliata) in Korean Coastal Waters. 1. Chinhae Bay

Yoo, Kwang-Il, Kim, Young-Ok and \*Kim, Dong-Yup

(Department of Biology, Hanyang University, Seoul 133-179 and \*Korea Ocean Research  
and Development Institute, Ansan P.O. Box 29, 425-600, Korea)

### 한국산 유충섬모충류의 분류학적 연구

#### 1. 진해만

유 광 일 · 김 영 옥 · \*김 동 업

(한양대학교 자연과학대학 생물학과 · \*한국과학기술원해양연구소)

#### 적 요

본 연구는 해양생태계의 저차생산 단계의 생산자로 중요시 되고 있는 유충섬모충류(Tintinnina)의 분류학적 연구의 일환으로 진해만 일대에서 1978년부터 1984년까지 6년간에 걸쳐 채집된 시료와 1986년부터 1987년까지 추가 채집된 시료를 사용하여 유충섬모충류를 동정 분류한 결과, 총 6과 11속 28종이 출현하였다. 이들 28종은 모두 국내에서 처음으로 동정 분류된 것이므로 이를 한국산 미기록종으로 기재한다.

Key words: Taxonomy, Tintinnina, Chinhae Bay.

## INTRODUCTION

Planktonic ciliates are important components of the microzooplankton which are consuming smaller diatoms, dinoflagellates and other constituents of the ultra- and nanoplankton and serving as a food source for larger zooplankton (Beers and Stewart, 1971; Heinbokel and Beers, 1979; Stoecker and Sanders, 1985). In marine ecosystem the tintinnids, the most abundant ciliate microzooplankton are important links in the transfer of nanoplankton production to higher trophic levels and also have been used as the indicators of water mass (Balech, 1972; Hada, 1957).

In early 1800's taxonomical studies on tintinnids have been carried out by several authors: Ehrenberg, Claparede and Lachmann, Entz and Daday (Kofoid and Campbell, 1929). Following the previous works the monographs on tintinnids were published by Kofoid and Campbell (1929, 1939) and Campbell (1942). Since then many researchers have defined the tintinnid fauna over many regions of the world oceans: e.g., the Western Pacific (Hada, 1932b, c, 1937, 1938), the South Atlantic and Gulf of Mexico and Carribbean (Balech, 1948, 1968), the Mediterranean Sea (Tregouboff, 1957) and the St. Andrew Bay System, Florida (Cosper, 1972). But these taxonomical studies have been based solely on the characteristics of the lorica. Recently many workers have found a great deal of individual variation and the fine structure by means of SEM and TEM have been received ever increasing attention in taxonomy of tintinnid. (Gold, 1979, 1980; Laval, 1972).

The tintinnid fauna of Korean costal waters is still unknown, despite an importance for the area. Therefore, the taxonomical studies of tintinnids are necessary for clarifying the structure and population dynamics of marine planktonic community. The purpose of the present study, as a series of taxonomical studies on tintinnids in Korean coastal waters is to describe the tintinnids in Chinhae Bay with taxonomical notes of the recorded species.

## MATERIALS AND METHODS

Samplings were made monthly from four selected stations in Chinhae Bay from August 1979 to June 1984 and from April 1986 to March 1987 (Fig. 1).

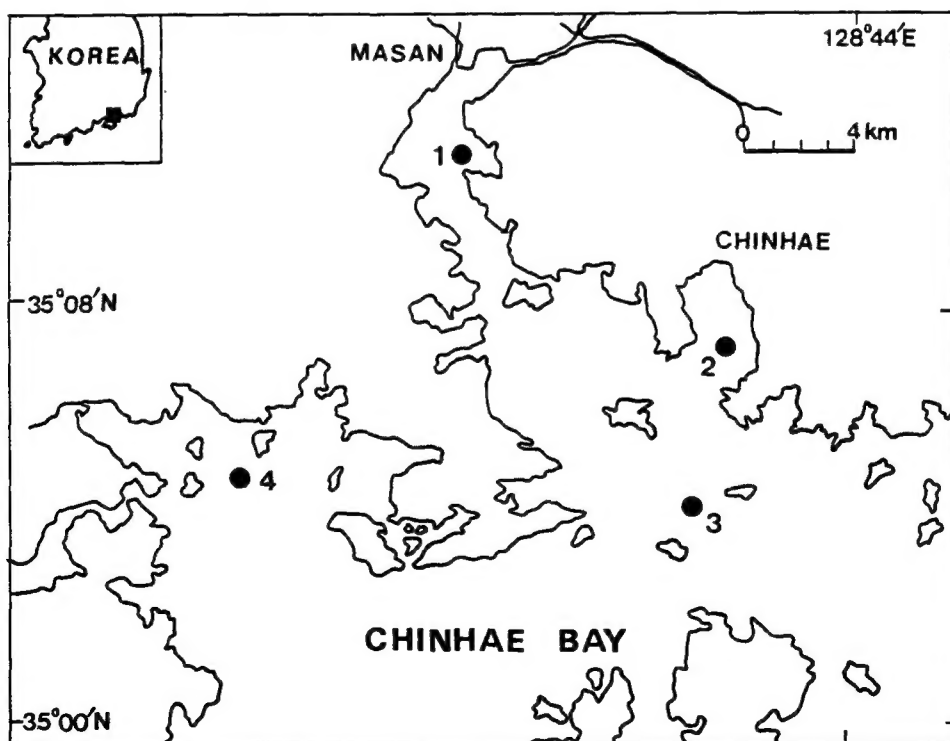


Fig 1. The sampling stations in Chinhae Bay.

Samples were collected by Marutoku type plankton net (mouth diameter 45cm, mesh aperture 100 $\mu$ m) from surface layer and then fixed with 10% buffered formalin on board.

For the qualitative analysis samples were thoroughly rinsed in distilled water and then specimens were mounted in glycerin jelly. Identification was carried out with light microscope in higher magnification. The specimens examined by SEM (JEOL JSM-35C) were prepared as prescribed by Yoo and Lee (1986).

The photography of specimen were performed using a OLYMPUS BH microscope equipped with a camera and for the purpose of invisible hyaline lorica, using a Carl Zeiss photomicroscope III with differential interference contrast.

Measurements of lorica were made on wet specimens contained in a Sedgwick-Rafter counting chamber using a OLYMPUS BHA equipped with a calibrated measuring eyepiece.

## RESULTS AND DISCUSSION

### Systematics

The following systematic treatment is based on Levine et al. (1980) and Corliss (1979, 1982) for familial and suprafamilial classification, and Loeblich and Tappan (1968) and Sano (1975) for sub-familial classification. Species identification is based on Kofoed and Campbell (1929, 1939), Campbell (1942) and Hada (1932a,b,c, 1935, 1937, 1938).

A total of 28 species, representing 6 families and 11 genera, have been identified and are new to Korean waters. The species of tintinnids found in the present study are listed as follows:

Phylum Ciliophora Doflein, 1901

Class Polyhymenophora Jankowski, 1967

Subclass Spirotrichia Butschli, 1889

Order Oligotrichida Butschli, 1887

Suborder Tintinnina Kofoed and Campbell, 1929

Family Tintinnididae Kofoed and Campbell, 1929

Genus *Leprotintinnus* Jorgensen, 1899

1. *Leprotintinnus neriticus* (Campbell, 1926)
  2. *L. nordqvisti* (Brandt, 1906)
  3. *L. simplex* Schmidt, 1901
- Family Codnellidae Kent, 1882
- Genus *Tintinnopsis* Stein, 1867
4. *Tintinnopsis angustior* (Jorgensen, 1924)
  5. *T. beroidea* Stein, 1867
  6. *T. butschlii* Daday, 1887
  7. *T. corniger* Hada, 1964
  8. *T. directa* Hada, 1932
  9. *T. gracilis* Kofoed and Campbell, 1929
  10. *T. kofoedi* Hada, 1932
  11. *T. lohmanni* Laackmann, 1906
  12. *T. radix* (Imhoff, 1886)

13. *T. tocaninensis* Kofoid and Campbell, 1929
14. *T. tubulosoides* Meunier, 1910  
Family Codonellopsidae Kofoid and Campbell, 1929  
Genus *Stenosemella* Jorgensen, 1924
15. *Stenosemella pacifica* Kofoid and Campbell, 1929
16. *S. parvicollis* (Marshall, 1934)  
Genus *Codonellopsis* Jorgensen, 1924
17. *Codonellopsis nipponica* Hada, 1964  
Family Metacylididae Kofoid and Campbell, 1929  
Genus *Metacylis* Jorgensen, 1924
18. *Metacylis corbula* Kofoid and Campbell, 1929  
Genus *Helicostomella* Jorgensen, 1924
19. *Helicostomella longa* (Brandt, 1906)
20. *H. subulata* (Ehrenberg, 1833)  
Family Ptychocyliidae Kofoid and Campbell, 1929  
Genus *Favella* Jorgensen, 1924
21. *Favella azorica* (Cleve, 1900)
22. *F. ehrenbergii* (Claparede and Lachmann, 1858)
23. *F. taraiikaensis* Hada, 1932  
Family Tintinnidae Claparede and Lachmann, 1858  
Genus *Amphorides* Daday, 1887
24. *Amphorides amphora* (Claparede and Lachmann, 1858)  
Genus *Amphorellopsis* Kofoid and Campbell, 1929
25. *Amphorellopsis acuta* (Schmidt, 1901)  
Genus *Eutintinnus* Kofoid and Campbell, 1939
26. *Eutintinnus lususundae* (Entz, 1885)
27. *E. tubulosus* (Ostenfeld, 1899)  
Genus *Salpingella* Jorgensen, 1924
28. *Salpingella laminata* Kofoid and Campbell, 1939

#### Suborder Tintinnina Kofoid and Campbell, 1929

Tintinnina with a cylindrical or cone-shaped soft body, attached inside a lorica; with 12-24 membranelles in the adoral zone and somatic ciliature though reduced and inconspicuous; lorica secreted, often agglomerating particles of the secreted substance and sometimes incorporating biogenic particles include fragments of diatom frustules and coccoliths; the shape of lorica very diversified in the various species, therefore, being used as key characters of a diagnostic value; with usually 2, macronuclei and micronuclei; generally free-swimming; with widespread distribution as members of marine pelagic and neritic plankton, but several in freshwater habitats.

#### Key to families

1. Lorica with only the fine primary structure in the wall ..... Tintinnidae
- Lorica with secondary structure in the wall ..... 2
2. Lorica with agglomerated foreign particles ..... 3

- Lorica with hyaline structure or fine reticulations ..... 4
3. Lorica without hyaline structure ..... Codonellidae
- Lorica with hyaline structure ..... Codonellopsidae
4. Lorica with fine reticulations ..... Ptychocyliidae
- Lorica with hyaline structure ..... 5
5. Lorica with spiral structure ..... Metacyliidae
- Lorica without spiral structure ..... Tintinnidae

#### Family Tintinnidae Kofoid and Campbell, 1929

Lorica with usually tubular or diversely saccular in form; sometimes with suboral spiral structure; wall soft and gelatinous in the main, with freely agglomerating particles of wall material and foreign bodies. Includes one genus, *Leprotintinnus*.

#### Genus *Leprotintinnus* Jorgensen, 1899

Lorica elongate, tube-shaped, open at both ends, sometimes with spiral structures; no collar; surface viscous, freely agglomerating foreign bodies. Includes three species as follows: *Leprotintinnus neriticus*, *L. nordqvisti* and *L. simplex*.

#### Key to species

1. Lorica simple tubular, without an aboral flare ..... 2
- Lorica with a distinct aboral flare ..... *L. nordqvisti*
2. Larger lorica with a length above 300  $\mu\text{m}$  ..... *L. neriticus*
- Smaller lorica with a length 200  $\mu\text{m}$  ..... *L. simplex*

#### 1. *Leprotintinnus neriticus* (Campbell, 1926) (pl. 1, figs. 1,2)

*Tintinnus neriticus* Campbell, 1926 (pp. 237-239, fig.1).

*Leprotintinnus neriticus*: Kofoid and Campbell, 1929 (p. 17, fig. 9).

**Material examined:** Chinhae Bay, St.3, Nov. 1981.

**Description:** Lorica simple, tubular; oral and aboral margins irregular, not flaring; open at both ends; wall thick, with irregular particles in a spiral on outer surface; length, 320-430  $\mu\text{m}$ ; oral diameter, 60  $\mu\text{m}$ ; aboral diameter, 50-55  $\mu\text{m}$ .

**Remarks:** This species closely resembles *L. simplex* in having a simple, tubular lorica but differs from in dimensions, length 400  $\mu\text{m}$ , oral diameter 60  $\mu\text{m}$ .

#### 2. *Leprotintinnus nordqvisti* (Brandt, 1906) (pl. 1; fig. 3)

*Tintinnopsis nordqvisti* Brandt, 1906 [cited from Kofoid and Campbell, 1929 (p. 17)].

*Leprotintinnus nordqvisti*: Kofoid and Campbell, 1929 (p. 17, fig. 13); Hada, 1935 (p. 244); 1938 (p. 91, fig. 3).

**Material examined:** Chinhae Bay, St. 3, Sept. 1981.

**Description:** Lorica cylindrical, with and an inverted funnel-shaped aboral flare; oral margin irregular, usually slightly flaring; aboral margin very ragged; aboral aperture large; wall showing a faint spiral structure, with particles aggregated more thickly on the aboral flare; length, 135-240  $\mu\text{m}$ ; oral diameter, 33-38  $\mu\text{m}$ , aboral diameter, 48-83  $\mu\text{m}$ .

**Remarks:** This species differs from the other species of *Leprotintinnus* in having a conspicuous great aboral flare.

**3. *Leptotintinnus simplex* Schmidt, 1901**

(pl. 1, fig. 4)

*Leptotintinnus simplex* Schmidt, 1901 [cited from Kofoid and Campbell 1929 (p. 18)]; Kofoid and Campbell, 1929 (p. 18, fig. 10); Hada, 1938 (p. 90, fig. 2).

**Material examined:** Chinhae Bay, St. 3, Nov. 1981.

**Description:** Lorica tubular, gradually tapering to aboral end without a flare or a constriction; open at both ends; wall comparatively thin, with sparse foreign particles laid spirally on the surface; length, 200  $\mu$ m; oral diameter, 38  $\mu$ m.

**Remarks:** This species is allied to *L. neriticus* in outline, but can be clearly distinguished from *L. neriticus* by its smaller size.

**Family Codnellidae Kent, 1882**

Lorica variously shaped, from globose to conical, or cylindrical; with or without a collar; aboral end rounded, pointed, with or without an aboral horn; wall composed of minute primary alveoli and much coarser secondary structures.

Differs from the Codonellopsidae in the absence of hyaline structure in the collar and from the Tintinnididae in the presence of secondary structure in the wall. Includes one genus, *Tintinnopsis*.

**Genus *Tintinnopsis* Stein, 1867**

Lorica agglomerated with a large proportion of particles of nonbiogenic origin. This genus included many neritic species. The identification of species in *Tintinnopsis* is rather difficult, because of the great irregularities in the lorica due to agglomeration.

Includes 11 species as follows: *Tintinnopsis angustior*, *T. beroidea*, *T. butschlii*, *T. coniger*, *T. directa*, *T. gracilis*, *T. kofoidi*, *T. lohmanni*, *T. radix*, *T. tocaninensis* and *T. tubulosoides*.

**Key to species**

1. Lorica with a cylindrical anterior region ..... 2  
     Lorica with a flaring anterior region ..... *T. butschlii*
2. No aboral opening ..... 3  
     Aboral opening present ..... 4
3. Aboral end with a branching aboral horn ..... *T. corniger*  
     Aboral end without a aboral horn ..... 5
4. Lorica with a inflating posterior region ..... *T. tocaninensis*  
     Lorica with a conical posterior region ..... 6
5. Aboral end rounded ..... *T. directa*  
     Aboral end acute or bluntly pointed ..... 7
6. Aboral region gradually tapering ..... *T. radix*  
     Aboral region abruptly tapering ..... *T. kofoidi*
7. Lorica with a inflating posterior region ..... 8  
     Lorica with a conical posterior region ..... 9
8. Lorica stout, with a spiral structure ..... *T. lohmanni*  
     Lorica slender, without a spiral structure ..... *T. gracilis*
9. Lorica stout bullet-shaped ..... *T. beroidea*  
     Lorica slender bullet-shaped ..... 10

10. Suboral region without a spiral structure ..... *T. angustior*  
 Suboral region with a spiral structure ..... *T. tubulosoides*

**4. *Tintinnopsis angustior* (Jorgensen, 1924) (pl. 1, fig. 5)**

*Tintinnopsis beroidea* var. *angustior* Jorgensen, 1924 (p. 67-68, fig. 73).

*Tintinnopsis acuminata*: Kofoed and Campbell, 1929 (p. 20, fig. 43); Marshall, 1969 (sheet 117, p. 3, fig. 8); Gold and Morales, 1975 (p. 523, fig. 5); 1976 (p. 383, fig. 6).

*Tintinnopsis angustior*: Hada, 1937 (p. 161, fig. 14).

**Material examined:** Chinhai Bay, St. 1, June 1982.

**Description:** Lorica slender bullet-shaped; bowl cylindrical in the main part; aboral region usually conical, sometimes rounded; aboral end blunt; wall thin, bearing a few foreign particles, no spiral structure; length, 40-60 $\mu$ m; oral diameter, 20-25 $\mu$ m.

**Remarks:** The species differs from *T. tubulosoides* in smaller size and in the lack of spiral structure and from *T. beroidea* in the slender lorica. Hada (1937) listed *T. acuminata* of Kofoed and Campbell (1929) as synonymous with *T. angustior*.

**5. *Tintinnopsis beroidea* Stein, 1867 (pl. 1, fig. 6)**

*Tintinnopsis beroidea* Stein, 1867 [cited from Kofoed and Campbell, 1929 (p. 28)]; Kofoed and Campbell, 1929 (p. 28, fig. 26); Hada, 1932b (p. 41, fig. 2); 1932c (p. 554); 1937 (p. 156, fig. 9); 1938 (p. 93, fig. 4); Kofoed and Campbell, 1939 (p. 38, pl. 1, fig. 1); Tregouboff, 1957 (p. 241, pl. 56, fig. 7); Marshall, 1969 (sheet 117, p. 6, fig. 19); Cosper, 1972 (p. 395, fig. 9); Gold and Morales, 1975 (p. 523, fig. 7).

**Material examined:** Chinhai Bay, St. 1, June 1982.

**Description:** Lorica bullet-shaped, with cylindrical anterior region and conical posterior region; oral margin irregular; aboral end closed and acute or bluntly pointed; wall with coarse agglomeration and sometimes, faint spiral structure on the suboral region; length, 40-60 $\mu$ m; oral diameter, 25-30 $\mu$ m.

**Remarks:** This species, the oldest in *Tintinnopsis*, very frequently occurs in coastal waters of the temperate zone, and differs from *T. angustior* in stouter proportions and coarser agglomeration.

**6. *Tintinnopsis butschlii* Daday, 1887 (pl. 1, figs. 7, 8)**

*Tintinnopsis Butschlii* Daday, 1887 [cited from Kofoed and Campbell, 1929 (p. 29)].

*Tintinnopsis butschlii*: Kofoed and Campbell, 1929 (p. 29, fig. 85); Hada, 1932c (p. 557, fig. 5); Balech, 1948 (p. 10, figs. 26-33); Tregouboff, 1957 (p. 241, pl. 56, fig. 9); Marshall, 1969 (sheet 117, p. 6, fig. 26).

**Material examined:** Chinhai Bay, St. 1, July 1983.

**Description:** Lorica typically bell-shaped; oral region broadly expanded and everted, about 120°-130°; constriction in the suboral region, with a spiral structure; aboral end hemispherical; wall with an arenaceous appearance due to the high proportion of particles of nonbiogenic origin; length, 80-93 $\mu$ m; oral diameter, 73-85 $\mu$ m; the greatest transdiameter of the bowl, 35-43 $\mu$ m.

**Remarks:** This species is often confused with allied species, especially *T. mortensenii*. *T. mortensenii* was referred by Kofoed and Campbell (1929) and Cosper (1972). Differs from *T. butschlii* in the more spreading oral flare. Since the considerable variation of this species, *T. mortensenii* was reported by Balech (1948) as *T. butschlii* var. *mortensenii*. Also, this species resembles *T. dadayi*, but differs in less spreading oral flare.

**7. *Tintinnopsis corniger* Hada, 1964**

(pl. 1, fig. 9)

*Tintinnopsis corniger* Hada, 1964 (p. 2, fig. 2); Balech, 1968 (p. 169, figs. 5-7).**Material examined:** Chinhae Bay, St. 1, June 1982.

**Description:** Lorica with cylindrical anterior region and conical posterior region; oral margin generally entire; aboral horn distinguishably 1-4 branched; wall agglomerate, with mostly nonbiogenic particles except aboral horn; hyaline branched aboral horn with polygonal reticulation; length, 175-280 $\mu$ m; oral diameter, 30 $\mu$ m; length of aboral horn, 48-68 $\mu$ m.

**Remarks:** The notable feature of this species is the branched aboral horn. In several specimens, the spiral structure weakly develops on the suboral region. This species occurs only in summer.

**8. *Tintinnopsis directa* Hada, 1932**

(pl. 2, fig. 1)

*Tintinnopsis patula*: Kofoed and Campbell, 1929 (p. 43, fig. 62).*Tintinnopsis directa* Hada, 1932c (p. 557, fig. 4); 1938 (p. 99, fig. 12); Balech, 1968 (p. 167, fig. 3).**Material examined:** Chinhae Bay, St. 4, Aug. 1983.

**Description:** Lorica tall campanulate; oral margin irregular, flaring; suboral region somewhat tapering, with spiral turns; posterior region subspherical, with a rounded aboral end; wall rather coarse in the posterior part; length, 85-105 $\mu$ m; oral diameter, 38-43 $\mu$ m; the greatest transdiameter of the bowl, 35-43 $\mu$ m.

**Remarks:** This species is widely distributed in coastal waters of tropical and temperate region, and differs from *T. dadayi* in the elongated lorica.

**9. *Tintinnopsis gracilis* Kofoed and Campbell, 1929**

(pl. 2, fig. 2)

*Tintinnopsis gracilis* Kofoed and Campbell, 1929 (p. 36, fig. 37); Hada, 1935 (p. 244); 1938 (p. 96, fig. 9); Balech, 1948 (p. 7, figs. 17-18); Hedin, 1975 (p. 128, figs. 7g, h).**Material examined:** Chinhae Bay, St. 2, Nov. 1980.

**Description:** Lorica finger-shaped, with cylindrical anterior region and slightly swollen posterior region; oral margin comparatively irregular; aboral region convex conical with a blunt aboral end; wall coarsely agglomerated without a spiral structure; length, 123 $\mu$ m; oral diameter, 30 $\mu$ m; the greatest transdiameter of the bowl, 40 $\mu$ m.

**Remarks:** This is probably a tropical species. The outline of the lorica is irregular owing to a coarse agglomeration of the wall.

**10. *Tintinnopsis kofoidi* Hada, 1932**

(pl. 2, fig. 3)

*Tintinnopsis kofoidi* Hada, 1932a (p. 210, figs. 2, 3); 1932b (p. 44, fig. 6); 1932c (p. 560, fig. 9); 1937 (p. 165); Balech, 1948 (p. 3, figs. 10, 12); Cosper, 1972 (p. 397, fig. 3); Gold and Morales, 1975 (p. 523, fig. 9).**Material examined:** Chinhae Bay, St. 3, Apr. 1983.

**Description:** Lorica elongated, inverted bottle-shaped, consisting of a bowl contracting abruptly to an aboral horn; oral margin formed irregularly; bowl cylindrical, conical aborally; aboral horn tubular; aboral tip open usually obliquely; wall subuniform in thickness, irregularly agglomerated, sometimes with spiral turns on the anterior region; length, 190-240 $\mu$ m; oral diameter, 33-38 $\mu$ m; length of aboral horn, 20-40 $\mu$ m.

**Remarks:** Differs from *T. cylindrica* in the presence of an aboral opening and from *T. radix* in the possession of a shorter horn. This species was described by Hada (1932c, 1937) and Cosper (1972) without spiral structure.



**11. *Tintinnopsis lohmanni* Laackmann, 1906**

(pl. 2, fig. 4)

*Tintinnopsis lohmanni* Laackmann, 1906 [cited from Hada, 1932c (p. 556)]; Hada, 1932c (p. 556, fig. 3); 1937 (p. 168, fig. 20); Hedin, 1975 (p. 127, figs. 6e, f).

*Tintinnopsis turbo*: Kofoed and Campbell, 1929 (p. 49, fig. 19); Marshall, 1969 (sheet 117, p. 10, fig. 51).

*Tintinnopsis vasculum*: Kofoed and Campbell, 1929 (p. 50, fig. 29); Marshall, 1969 (sheet 117, p. 10, fig. 50); Gold and Morales, 1975 (p. 524, fig. 19); 1976 (p. 387, fig. 14).

**Material examined:** Chinhae Bay, St. 1, Mar. 1984.

**Description:** Lorica vase-like, with a cylindrical suboral region; oral margin more or less irregular; bowl expanding roundly; 1-3 spiral turns in the suboral region; aboral region rounded or convex conical; wall coarsely agglomerated; length, 63-75 $\mu$ m; oral diameter, 45-53 $\mu$ m; bowl diameter, 50-55 $\mu$ m.

**Remarks:** The length of a cylindrical suboral region is widely variable. Biernacka (1952) reported that longer specimens generally occur in cold waters, while smaller in warm waters. Also, Hada (1937) observed the seasonal variation in length and listed *T. turbo* and *T. vasculum* of Kofoed and Campbell (1929) as synonymous with *T. lohmanni*. In the Chinhae Bay, this species is probably occurred in cold waters, from late autumn to early spring.

**12. *Tintinnopsis radix* (Imhoff, 1886)**

(pl. 2, figs. 5,6)

*Codonella radix* Imhoff, 1886 [cited from Kofoed and Campbell, 1929 (p. 45)].

*Tintinnopsis radix*: Kofoed and Campbell, 1929 (p. 45, fig. 93); Hada, 1932c, (p. 560, fig. 10); 1935 (p. 244), 1937 (p. 166, fig. 18); 1938 (p. 100, fig. 14); Kofoed and Campbell, 1939 (p. 41); Tregouboff, 1957 (p. 241, pl. 56, fig. 12); Marshall, 1969 (sheet 117, p. 9, fig. 35); Cosper, 1972 (p. 401, figs. 6, 7); Gold and Morales, 1976 (p. 387, fig. 11).

**Material examined:** Chinhae Bay, St. 4, June 1983.

**Description:** Lorica very much elongated, with a long anterior cylinder and a posterior cone; aboral region gradually tapering into an aboral horn; aboral horn usually curved more or less, with an irregularly formed aboral opening typically set laterally as gouges; wall thin and fragile, some evidence of a weak spiral structure; length, 290-350 $\mu$ m; oral diameter, 43-48 $\mu$ m.

**Remarks:** Differs from *T. kofoedi* by having a longer aboral horn and in the lack of parallel sides. This is cosmopolitan species and exceedingly variable in length. Great variability in length of horn (possibly broken during collection) gives extensive length range.

**13. *Tintinnopsis tocaninensis* Kofoed and Campbell, 1929**

(pl. 2, fig. 7)

*Tintinnopsis tocaninensis* Kofoed and Campbell, 1929 (p. 48, fig. 46); Hada, 1932c (p. 559, fig. 8); 1935 (p. 244); Balech, 1948 (p. 6, figs. 13-16); Cosper, 1972 (p. 402, fig. 4).

*Tintinnopsis aperta* var. *tocaninensis*: Hada, 1938 (p. 101, fig. 15).

**Material examined:** Chinhae Bay, St. 4 Aug. 1983.

**Description:** Lorica elongate, with cylindrical anterior region and expanding posterior region; posterior region tapering distally into a stout aboral horn; aboral horn conical and obliquely or irregularly open at the tip; wall thick and coarse; length, 85-113 $\mu$ m; oral diameter, 18-25 $\mu$ m; the greatest transdiameter of the bowl, 23-33 $\mu$ m.

**Remarks:** Differs from *T. aperta* in having a longer, more rounded bulbous enlargement and a stouter horn. This was described by Hada (1938) as *T. aperta* var. *tocaninensis*.

**14. *Tintinnopsis tubulosoides* Meunier, 1910**

(pl. 2, fig. 8)

*Tintinnopsis tubulosoides* Meunier, 1910 (pp. 139, 140, pl. 12, figs. 10, 11); Kofoid and Campbell, 1929 (p. 49, fig. 74); Hada, 1932b (p. 43, fig. 5); Marshall, 1969 (sheet 117, p. 10, fig. 12); Gold and Morales, 1975 (p. 524, fig. 16).

**Material examined:** Chinhae Bay, St. 1, June 1982.

**Description:** Lorica elongate bullet-shaped; oral margin more or less smooth; bowl cylindrical in the anterior region; aboral region contracting gradually, conical; aboral end generally acute, sometimes pointed bluntly; wall comparatively thin, with a few faint spiral turns in the suboral region, agglomerated particles somewhat sparse.

**Remarks:** Differs from *T. beroidea* in the long cylindrical bowl, from *T. angustior* in having spiral structure.

**Family Codonellopsidae Kofoid and Campbell, 1929**

Lorica with hyaline collar and bowl patterned; hyaline collar with annular or spiral structure; bowl generally ovate; aboral end closed, rounded, pointed, or with a aboral horn; wall of two types, hyaline with primary structure only in the collar, and with coarse secondary structure throughout the bowl; marine only. Differs from all other families in having a hyaline collar and a patterned bowl. Includes two genera, *Stenosemella* and *Codonellopsis*.

**Key to genera**

- 1. Lorica with a short collar ..... *Stenosemella*
- Lorica with a long collar ..... *Codonellopsis*

**Genus *Stenosemella* Jorgensen, 1924**

Lorica minute, ovoid, consisting of low collar and ovate bowl; collar short, hyaline; bowl usually broadest in the anterior region. Most of species of this genus are neritic inhabitants. Differs from *Codonellopsis* in the very short collar. Includes two species, *Stenosemella pacifica* and *S. parvicollis*.

**Key to species**

- 1. Collar with semicircular fenestrae ..... *S. pacifica*
- Collar with arched fenestrae ..... *S. parvicollis*

**15. *Stenosemella pacifica* Kofoid and Campbell, 1929**

(pl. 2, fig. 9)

*Stenosemella pacifica* Kofoid and Campbell, 1929 (p. 70, fig. 133); Balech, 1968 (p. 170, fig. 9).

**Material examined:** Chinhae Bay, St. 2, Apr. 1983.

**Description:** Lorica small ovate; short hyaline collar, upper part of the collar slightly constricted, with a row of semicircular 8-9 openings around its base; size of the fenestrae uneven; bowl widest near the middle, with squarish shoulder; aboral end subrounded but not distinctly pointed; wall of the collar hyaline but bowl thick and coarsely agglomerated, especially on the squarish shoulder; length, 35-40µm; oral diameter, 20µm; bowl diameter, 30µm.

**Remarks:** Kofoid and Campbell (1939) and Campbell (1942) transferred three species, *Stenosemella pacifica*, *S. inflata* and *S. punctata* with semilunar windows in the collar from genus *Stenosemella* to a new genus *Luminella*, family Dictyocystidae. But in other species, *S. oliva*, *S. ventricosa* and *S. stenii*,

have been also observed the windows by the scanning electron microscopy of Gold and Morales (1975, 1976) and Gold (1980). Therefore, the most species in genus *Stenosemella* have windows in the collar. Some species, unknown with windows or not, have a possibility to be transferred. Therefore, it is invalid that several species with windows transferred from *Stenosemella* to a new genus *Luminella*. And this species is included in the genus *Stenosemella* as Kofoid and Campbell (1929).

**16. *Stenosemella parvicollis* (Marshall, 1934)**

(pl. 3, figs. 1, 2)

*Codonellopsis parvicollis* Marshall, 1934 [cited from Hada, 1938 (p. 106)].

*Stenosemella parvicollis*: Hada, 1935 (p. 244); 1938 (p. 106, fig. 21).

**Material examined:** Chinhae Bay, St. 2, Nov. 1980.

**Description:** Lorica with a short hyaline collar and a ovate bowl; collar provided with a row of 8-9 arched fenestrae; bowl with the widest near the middle, with squarish shoulder; aboral end rounded, blunt, but distinctly point; wall of the bowl coarsely agglomerated, sometimes with biogenetic particles including fragments diatom frustules; length, 60-65 $\mu$ m; oral diameter, 25-28 $\mu$ m; bowl diameter, 50-53 $\mu$ m; collar length, 6-10 $\mu$ m.

**Remarks:** Differs from *S. pacifica* in having a longer lorica and a row of arched fenestrae. This species was originally described by Marshall (1934) as a species of *Codonellopsis*, but it has been recognized by Hada (1938) to belong to the genus *Stenosemella* because of the possession of the short collar without spiral structure.

**Genus *Codonellopsis* Jorgensen, 1924**

Lorica consisting of a collar and a bowl, both easily distinguished in structure; collar hyaline, usually elongate and cylindrical with spiral turns; bowl globose or ellipsoidal, with or without aboral horn; wall of the collar composed of a ground secreted substance and of the bowl having agglomerated materials on the surface. In this genus many neritic species are included and most of them are occurred in warm waters. Includes one species, *Codonellopsis nipponica*.

**17. *Codonellopsis nipponica* Hada, 1964**

(pl 3, fig. 3)

*Codonellopsis nipponica* Hada, 1964 (p. 3, fig. 3); Yamaji, 1984 (p. 172, pl. 55, fig. 13).

**Material examined:** Chinhae Bay, St. 1, June 1983.

**Description:** Lorica consisting of an annular collar and a bowl; collar with a leiotropic spiral of 5-6 and without fenestrae appearing in the dilated base; bowl mainly ovate shaped but sometimes elliptically elongate; aboral end rounded or rarely bluntly pointed; wall of the collar hyaline but bowl thick and coarsely agglomerated; length, 115-133 $\mu$ m, oral diameter, 58-60 $\mu$ m; bowl diameter, 80-83 $\mu$ m; collar length, 20-35 $\mu$ m.

**Remarks:** Differs from *C. morchella* and *C. ostensfeldi* in the lack of fenestrae on the collar. Sometimes, this species shows a collar with a leiotropic spiral of 6 and up in the present investigation.

**Family Metacyclididae Kofoid and Campbell, 1929**

Always with coiled lamina forming the whole or part the lorica; aboral end open or closed; with or without collar; wall without agglomerated particles. The family name, Coxliellidae, has become invalid by Corliss (1979). Because the species in the genus *Coxliella*, though a popularly used name, may be only stages in the life cycle of species of other genera. Therefore, the family name, Coxliellidae, has been renamed to Metacyclididae by Corliss (1979).

**Key to genera**

1. Lorica usually short and wide, oval ..... *Metacylis*  
 Lorica elongate, tubular ..... *Helicostomella*

**Genus *Metacylis* Jorgensen, 1924**

Lorica usually short and wide, oval, in some species elongate capsular; usually with a wide mouth; collar with low spiral turns; wall hyaline, laminar structure. Includes one species, *Metacylis corbula*.

**18. *Metacylis corbula* Kofoed and Campbell, 1929 (pl. 3, fig. 4)**

*Metacylis corbula* Kofoed and Campbell, 1929 (p. 199, fig. 376); Hada, 1938 (p. 135, fig. 52); Kofoed and Campbell, 1939 (p. 104, pl. 6, fig. 5); Marshall, 1969 (sheet 120, p. 5, fig. 18).

**Material examined:** Chinhae Bay, St. 2, Sept. 1981.

**Description:** Lorica basket-shaped; collar with 4 spiral turns confined to the short, constricted neck region; oral margin entire; bowl broadly ovoidal, with rounded shoulder; aboral end broadly rounded without point; wall of both collar and bowl hyaline; length, 100 $\mu$ m; oral diameter, 60-68 $\mu$ m; bowl diameter, 68-75 $\mu$ m.

**Remarks:** The specimens observed in the present investigation are generally larger in size than those of the collection examined by Kofoed and Campbell (1929, 1939) and Hada (1938).

**Genus *Helicostomella* Jorgensen, 1924**

Lorica elongate, tubular as a pencil; oral margin with or without minute triangular teeth; bowl cylindrical in the suboral part with a number of spiral turns; aboral region conical with an aboral horn; wall thin and hyaline. Includes two species as follows: *Helicostomella longa* and *H. subulata*.

**Key to species**

1. Oral margin with short trigonal teeth ..... *H. subulata*  
 Oral margin without dentation ..... *H. longa*

**19. *Helicostomella longa* (Brandt, 1906) (pl. 3, figs. 5, 6)**

*Tintinnus mediterraneus* var. *longs* Brandt, 1906 [cited from Kofoed and Campbell, 1929 (p. 106)].

*Helicostomella longa*: Kofoed and Campbell, 1929 (p. 106, fig. 206); Hada, 1938 (p. 115, fig. 32); Kofoed and Campbell, 1939 (p. 106, pl. 6, figs. 8, 17); Campbell, 1942 (p. 43).

**Material examined:** Chinhae Bay, St. 1, June 1982.

**Description:** Lorica small, bullet-shaped; oral margin smooth without dentation; 3-9 spiral turns on the suboral region; bowl expanding slightly; aboral end usually pointed, sometimes with a poorly marked aboral horn; wall hyaline; length, 70-78 $\mu$ m; oral diameter, 18-19 $\mu$ m; bowl diameter, 19-23 $\mu$ m.

**Remarks:** Differs from *H. subulata* in smaller size and in the lack of dentation on the oral margin. Numerous small grooves are observed on the surface of lorica by the scanning electron microscope. In the Chinhae Bay, this species is probably occurred in summer.

**20. *Helicostomella subulata* (Ehrenberg, 1833) (pl. 3, figs. 7, 8)**

*Tintinnus subulatus* Ehrenberg, 1833 [cited from Kofoed and Campbell, 1929 (p. 107)].

*Helicostomella subulata*: Kofoed and Campbell, 1929 (p. 107, fig. 209); Hada, 1932b (p. 46, fig. 10); 1937 (p.

185, fig. 31); Tregouboff, 1957 (p. 245, pl. 57, fig. 23); Marshall, 1969 (sheet 120, p. 6, fig. 24); Cosper, 1972 (p. 407, figs. 17, 18); Hedin, 1975 (p. 130, figs. 9c, e, f); Gold and Morales, 1975 (p. 525, fig. 27); 1976 (p. 388, fig. 3(1)); Balech, 1980 (p. 6, figs. 6, 8).

*Helicostomella fusiformis*: Kofoed and Campbell, 1929 (p. 105, fig. 207); Hada, 1932b (p. 46, fig. 9); 1937 (p. 183, fig. 30); Marshall, 1969 (sheet 120, p. 6, fig. 23).

*Helicostomella edentata*: Kofoed and Campbell, 1929 (p. 105, fig. 208); Marshall, 1969 (sheet 120, p. 6, fig. 22).

*Helicostomella kiliensis*: Kofoed and Campbell, 1929 (p. 105, fig. 210); Marshall, 1969 (sheet 120, p. 6, fig. 25).

*Helicostomella lemairei* Balech, 1942 (p. 249, figs. 7-9).

**Material examined:** Chinhae Bay, St. 4, Dec. 1981.

**Description:** Lorica elongate as a pencil; oral margin somewhat flaring, with about 24-32 short trigonal teeth; suboral region with 5-25 spiral bands, sometimes this spiral bands denticular, fading posteriorly, but more prominent on anterior bands; aboral region conical, tapering posteriorly to an aboral horn; a few, irregularly curved striae run into an aboral end; length, 178-220 $\mu$ m; oral diameter, 21-23 $\mu$ m.

**Remarks:** The species differs from *H. fusiformis* in the size of the lorica and the lack of an aboral bulge of the bowl. But sometimes, it is very difficult to distinguish between *H. subulata* and *H. fusiformis*. Because there are many specimens as intermediate forms. And also, Paranjape (1980) in his laboratory culture commented such a variation. Therefore, Balech (1980) included *H. subulata*, *H. edentata*, *H. kiliensis* and *H. lemairei* as a synonym of this species. In the present investigation, peculiar pores were found in the aboral region of the lorica from several collections by scanning electron microscope.

#### Family Ptychocyliidae Kofoed and Campbell, 1929

Lorica usually bell-shaped; collar without flaring, sometimes supplemental spiral structure present; often with an aboral horn; wall composed of a fine polygonal reticulation. Includes one genus, *Favella*.

#### Genus *Favella* Jorgensen, 1924

Lorica bell-shaped; oral margin entire or denticulate; sometimes provided with a collar consisting of a number of spiral turns; bowl campanulate, rounded or convex conical in the aboral region; aboral horn usually present; wall bi- or trilamellate, compact in an aboral horn, composed of a fine polygonal reticulation. Includes three species as follows: *Favella azorica*, *F. ehrenbergii* and *Favella taraiakensis*.

#### Key to species

1. Aboral end without a aboral horn ..... *F. azorica*  
    Aboral end with a aboral horn ..... 2
2. Suboral region without a inflation ..... *F. ehrenbergii*  
    Suboral region with a inflation ..... *F. taraiakensis*

#### 21. *Favella azorica* (Cleve, 1900)

(pl. 3, fig. 9)

*Undella azorica* Cleve, 1900 [cited from Kofoed and Campbell, 1929 (p. 151)].

*Favella azorica*: Kofoed and Campbell, 1929 (p. 151, fig. 284); Hada, 1938 (p. 120, fig. 37); Kofoed and Campbell, 1939 (p. 123, pl. 7, fig. 9); Campbell, 1942 (p. 44, fig. 56); Marshall, 1969 (sheet 121, p. 4, fig. 7).

**Material examined:** Chinhae Bay, St. 2, June 1983.

**Description:** Lorica inverted bell-shaped; oral margin entire; collar with annular band usually single; bowl cylindrical in the anterior half, posteriorly convex conical; aboral end acute but lack of the aboral horn; wall hyaline, distinctly separated in the dilated band below the annular ring and in the aboral end, with a hardly visible reticulation; length, 160-180 $\mu$ m; oral diameter, 68-73 $\mu$ m.

**Remarks:** Differs from *F. ehrenbergii* and *F. taraikaensis* in the lack of an aboral horn and in the thinner wall. At this time, although there is no evidence supporting the existence of an intergradation, this species has a possibility that does not constitute a species, but is the convergence of the form elaborated during one stage of life-cycle of *F. ehrenbergii*, as the form genus *Coxliella* (Laval-Peuto, 1977, 1981).

**22. *Favella ehrenbergii*** (Claparede and Lachmann, 1858)

(pl. 4, figs. 1, 2)

*Tintinnus Ehrenbergii* Claparede and Lachmann, 1858 [cited from Kofoed and Campbell, 1929 (p. 152)].

*Favella ehrenbergii*: Kofoed and Campbell, 1929 (p. 152, fig. 280); Hada, 1937 (p. 186, fig. 32); Tregouboff, 1957 (p. 246, pl. 58, fig. 1); Marshall, 1969 (sheet 121, p. 4, pl. 6, fig. 9).

**Material examined:** Chinhae Bay, St. 1, Aug. 1981.

**Description:** Lorica campanulate; collar usually short and built with a single annular band, sometimes very developed with a long spiral bands; oral margin uneven; bowl cylindrical in the anterior region but posterior region roundly tapering to an aboral horn; aboral horn twisted, with many varieties according to developing stage; wall perfectly separated except the basal of aboral horn, with comparatively regular reticulation; length, 210-290 $\mu$ m; oral diameter, 80-90 $\mu$ m.

**Remarks:** *Favella ehrenbergii* is the oldest and cosmopolitan species in genus *Favella*. Many varieties and forms of the species have been described. Because of its large variability, this species has serious problems in the identification.

The life cycle of *F. ehrenbergii* was investigated by the laboratory culture of Laval-Peuto (1976, 1977, 1981). She has observed discontinuous phenotypes considered until now as different species and even different genera. And then, she suggested that the spiral wound loricae named *Coxliella* do not constitute a genus, but are the convergence of the forms elaborated by quite different genera during one stage of their life cycle. At the same time she included *Favella markusowskyi*, *F. helgolandica*, *F. fistulicauda*, *Coxliella annulata*, *C. ampla*, *c. decipiens* as a synonym of this species.

In Chinhae Bay, the loricae of *Coxliella* form were observed in summer.

**23. *Favella taraikaensis*** Hada, 1932

(pl. 4, figs. 3, 4)

*Favella taraikaensis* Hada, 1932b (p. 47, fig. 11); 1937 (p. 187, fig. 33).

**Material examined:** Chinhae Bay, St. 1, Apr. 1983.

**Description:** Lorica tall goblet-shaped; oral margin entire; collar more or less flaring, with a few spiral bands; suboral region slightly expanded below the nuchal constriction; aboral region gradually narrowing into a conical aboral end; aboral end usually elongate, ornamented with longitudinal striae on the surface; wall completely separated in large specimens, with irregular reticulation, sometimes ovate fenestrae in the suboral dilated region; length, 130-223 $\mu$ m; oral diameter, 65-73 $\mu$ m.

**Remarks:** The species differs from *F. ehrenbergii* in possession of suboral inflation and of striae on the aboral horn. Sometimes, aboral horn reduces as *F. azorica* and suboral inflation reduced as *F. ehrenbergii*.

### Family Tintinnidae Claparede and Lachmann, 1858

Lorica variously formed, usually cylindrical or trumpet shaped; oral region flaring; aboral end open or closed; wall hyaline, and usually without secondary structure. Includes three genera as follows: *Amphorides*, *Amphorellopsis* and *Eutintinnus*.

#### Key to genera

1. No aboral opening ..... 2  
    Aboral opening present ..... 3
2. Aboral end flattened ..... *Amphorides*  
    Aboral end acute ..... *Amphorellopsis*
3. Aboral region without fins ..... *Eutintinnus*  
    Aboral region with fins ..... *Salpingella*

### Genus *Amphorides* Strand, 1926

Lorica vase-shaped; oral margin circular, entire; bowl always provided with 3 or 4 wall-marked fins; aboral end usually truncated; wall hyaline, thickened in the collar. This generic name is a replacement name for genus *Amphorella*, preoccupied generic name (Corliss, 1960). Differs from *Amphorellopsis* in the truncated aboral end. Includes one species, *Amphorides amphora*.

#### 24. *Amphorides amphora* (Claparede and Lachmann, 1858) (pl. 4, fig. 5)

*Tintinnus amphora* Claparede and Lachmann, 1858 [cited from Kofoed and Campbell, 1929 (p. 309)].

*Amphorella amphora*: Kofoed and Campbell, 1929 (p. 309, fig. 586); 1939 (p. 330, pl. 28, fig. 20); Campbell, 1942 (p. 112).

*Amphorella brandti*: Kofoed and Campbell, 1929 (p. 309, fig. 588); Hada, 1935 (p. 247); 1938 (p. 165, fig. 82); Gold and Morales, 1977 (p. 585, fig. 15); Yuki, 1984 (p. 56).

*Amphorides amphora*: Marshall, 1969 (sheet 126, p. 3, fig. 7).

*Amphorides brandti*: Cosper, 1972 (p. 411, fig. 22).

**Material examined:** Chinhae Bay, St. 2, Sept. 1980.

**Description:** Lorica elongate, vase-like shaped; oral margin thin and smooth; collar widely flaring and funnel shaped, reaching to 90°; bowl generally cylindrical; aboral region convex conical; aboral end concavely flattened; 3 flat, blade like fins, stretching the last 1/2-2/3 of the lorical length and giving the lorica a triangular appearance in aboral cross section; wall hyaline, thickened in the region of the collar and becoming thin aborally; length, 145-168µm; oral diameter, 45-48µm.

**Remarks:** Kofoed and Campbell (1939) listed *A. brandti* of Kofoed and Campbell (1929) as synonymous with *A. amphora*. Campbell (1942) synonymized *A. brandti* with *A. amphora*. But Cosper (1972) did not accept their interpretation, since the reclassification made the concept of this species too broad and he has stated that *A. brandti* differs from *A. amphora* by having a more slender column. In the present paper, this species is described as Campbell (1942) because the usual procedure of employing lorical dimensions and the length: width ratio were found to be unsatisfactory for classification of tintinnids (Gold and Morales, 1975).

### Genus *Amphorellopsis* Kofoed and Campbell, 1929

Lorica usually elongate, consisting of a low funnel shaped collar and a fusiform bowl; aboral end

pointed; aboral region with 3-6 fins developed; wall single-layered except an anterior flaring part of the lorica. Differs from *Amphorides* in pointed aboral end. Includes one species, *Amphorellopsis acuta*.

**25. *Amphorellopsis acuta* (Schmidt, 1901)**

(pl. 4, fig. 6)

*Amphorella acuta* Schmidt, 1901 [cited from Kofoed and Campbell, 1929 (p. 315)].

*Amphorellopsis acuta*: Kofoed and Campbell, 1929 (p. 315, fig. 598); Hada, 1935 (p. 247); 1938 (p. 168, fig. 85); Kofoed and Campbell, 1939 (p. 334); Marshall, 1969 (sheet 126, p. 4, fig. 12); Cosper, 1972 (p. 412, fig. 21).

**Material examined:** Chinhae Bay, St. 2, Nov. 1980.

**Description:** Lorica convex conical; oral margin annular and smooth, thinning to a sharp edge; collar flaring (70°); anterior region cylindrical but posterior region slightly expanded; 3 fins stretching the last 1/2-2/3 of the lorical length and bowl circular in transection anteriorly and triangular posteriorly; aboral end a pyramid of 40°-50°, with slightly convex sides, contracting evenly to pointed antapex; wall hyaline and thicker in throat; length, 153-160µm; oral diameter, 43-48µm.

**Remarks:** Differs from all other species of *Amphorellopsis* by possessing three fins. This species is a type species in genus *Amphorellopsis*.

**Genus *Eutintinnus* Kofoed and Campbell, 1939**

Lorica with a form of a truncated cone or cylinder, opening at both ends; oral margin often flaring and thickened to make a brim, usually entire, sometimes denticulated; shaft generally tapering gradually to an aboral end; wall hyaline, single-layered. Differs from all other genera in the lack of all structural differentiations of the oral and aboral ends. Includes two species as follows: *Eutintinnus lususundae* and *E. tubulosus*.

**Key to species**

1. Lorica long, with a flaring oral margin ..... *E. lususundae*  
 Lorica short, without a flaring oral margin ..... *E. tubulosus*

**26. *Eutintinnus lususundae* (Entz, 1885)**

(pl. 4, fig. 7)

*Tintinnus Lusus-undae* Entz, Sr., 1885 [cited from Kofoed and Campbell, 1929 (p. 335)].

*Tintinnus lusus-undae*: Kofoed and Campbell, 1929 (p. 335, fig. 656); Hada, 1935 (p. 248); 1938 (p. 173, fig. 88).

*Tintinnus tubulosus*: Hada, 1935 (p. 247).

*Eutintinnus lusus-undae*: Kofoed and Campbell, 1939 (p. 368, pl. 32, fig. 3); Campbell, 1942 (p. 121, fig. 125); Tregouboff, 1957 (p. 255, pl. 60, fig. 11); Marshall, 1969 (sheet 127, p. 3, fig. 7); Yuki, 1984 (p. 57).

**Material examined:** Chinhae Bay, St. 2, May 1980.

**Description:** Lorica long, subcylindrical; oral margin annular and smooth; suboral region flaring outwardly; shaft subcylindrical tapering tube without local inflations or constrictions, decreasing evenly from throat to aboral end; aboral end wide-opened, neither flare nor brim; wall homogeneous hyaline but slightly thicker in throat; length, 250-310µm; oral diameter, 50-53µm; aboral diameter, 30-35µm.

**Remarks:** The classification of genus *Eutintinnus* was probably based upon dimensions of the lorica besides differences of the form, but being generally variable within a wide range, the length of the lorica seems not to be a chief feature by which species are distinguished. Hence, the identification of this species has been principally carried out by differences in the form of the lorica.



**27. *Eutintinnus tubulosus* (Ostenfeld, 1899) (pl. 4, fig. 8)**

*Tintinnus tubulosus* Ostenfeld, 1899 [cited from Kofoed and Campbell, 1929 (p. 340)]; Kofoed and Campbell, 1929 (p. 340, fig. 651); Hada, 1937 (p. 211, fig. 53).

*Eutintinnus tubulosus*: Kofoed and Campbell, 1939 (p. 374, pl. 32, fig. 8); Campbell, 1942 (p. 125); Tregouboff, 1957 (p. 255); Marshall, 1969 (sheet 127, p. 4, fig. 11); Cosper, 1972 (p. 413, fig. 26).

**Material examined:** Chinhae Bay, St. 1, June 1982.

**Description:** Lorica short, truncated cone; oral margin and aboral margin opened without flaring; shaft with regularly contracting sides, truncated cone of  $4^{\circ}$ - $5^{\circ}$ ; wall very thin and hyaline throughout; length, 80-98 $\mu$ m; oral diameter, 16-20 $\mu$ m; aboral diameter, 13-16 $\mu$ m.

**Remarks:** This species differs from *E. lususundae* in its smaller dimensions and the absence of flaring oral margin. In general, specimens examined in the present investigation are comparatively small and slender.

**Genus *Salpingella* Jorgensen, 1924**

Lorica usually elongated, nail-shaped; oral margin entire, circular or polygonal; anteriorly cylindrical and posteriorly conical; always open posteriorly, with 4-9 fins; wall hyaline. Includes one species, *Salpingella laminata*.

**28. *Salpingella laminata* (Kofoed and Campbell, 1939) (pl. 4, fig. 9)**

*Salpingella lineata*: Kofoed and Campbell, 1929 (p. 354, fig. 678).

*Salpingella laminata* Kofoed and Campbell, 1939 (p. 388, pl. 33, fig. 1).

**Material examined:** Chinhae Bay, St. 4, Oct. 1981.

**Description:** Lorica stout, tubular shaped; oral margin slightly flaring to thin edge; suboral region contracting gradually; shaft subcylindrical in anterior region and convex conical in posterior region, narrowest in the middle part; 4 vertical fins on lower part of bowl, disappearing in middle, visible suborally aboral end blunt; wall uniformly thin throughout; length, 80-98 $\mu$ m; oral diameter, 11-15 $\mu$ m.

**Remarks:** Kofoed and Campbell (1939) listed *S. lineata* of Kofoed and Campbell (1929) as synonymous with *S. laminata*. This species is very narrow and easily overlooked.

**ABSTRACT**

Tintinnids, small ciliated protozoan, play an important roles as lower level producer in marine ecosystem. The present study, as a part of taxonomical studies on tintinnids in Korean coastal waters, has been carried out to clarify the primary faunal survey of the tintinnids in Chinhae Bay. The samples used for the present study were collected from four selected stations in Chinhae Bay during the period from August 1979 to June 1984 and from April 1986 to March 1987.

As a result 28 species in 11 genera distributed in six families were identified and described as new to Korean coastal waters.

## REFERENCES

- Balech, E., 1942. Tintinnoideos del estrecho Le Maire. *Physis*, **19**: 242-252.
- Balech, E., 1948. Tintinnoinea de Atlantida. *Comun. Mus. Argent. Cienc. Nat. Bernardino Rivadavia, Ser. Cienc. Nat. Zool.*, **7**: 1-23.
- Balech, E., 1968. Algunas especies nuevas o interesantes de Tintinnidos del Golfo de Mexico y Caribe. *Rev. Mus. Argent. Cienc. Nat. Bernardino Rivadavia Hidrobiologia*, **2**: 165-197.
- Balech, E., 1972. Los Tintinnidos indicadores de afloramientos de aguas (Ciliata). *Physis*, **31**: 519-528.
- Balech, E., 1980. Los Tintinnidos de la campana oceanografica productividad IV. Parte 1. *Physis*, **39**: 1-8.
- Beers, J. R. and G. L., Stewart, 1971. Micro-zooplankters in the plankton communities of the upper waters of the eastern tropical Pacific. *Deep-Sea Res.*, **18**: 861-883.
- Biernacka, I., 1952. Stuida nad rozrodem niektorych gatunkow rodzaju *Tintinnopsis* Stein. *Ann. Univ. Mariae Curie Skłodowska*, **6**: 211-247.
- Campbell, A. S., 1926. On *Tintinnus neriticus* sp. nov. from San Francisco Bay. *Univ. Calif. Publ. Zool.*, **29**: 237-239.
- Campbell, A. S., 1942. The oceanic Tintinnina of the plankton gathered during the last cruise of the Carnegie. Scientific results of Cruise VII of the Carnegie during 1928-1929 under the command of Captain J. P. Ault. *Publ. Carnegie Inst. Wash.*, **537**: 1-163.
- Corliss, J. O., 1960. The problem of homonyms among generic names of ciliated Protozoa, with proposal of several new names. *J. Protozool.*, **7**: 269-278.
- Corliss, J. O., 1979. The ciliated Protozoa: characterization, classification and guide to the literature, 2nd ed. Pergamon Press, London and New York, pp. 1-455.
- Corliss, J. O., 1982. Ciliophora. In: S. D. Parker ed., *Synopsis and classification of living organisms*, vol. 1. McGraw-Hill Book Co., Inc., New York, pp. 603-637.
- Cosper, T. C., 1972. Identification of tintinnids of the St. Andrew Bay System, Florida. *Bull. Mar. Sci.*, **22**: 391-417.
- Gold, K., 1979. Scanning electron microscopy of *Tintinnopsis parva*: studies on particle accumulation and the striae. *J. Protozool.*, **26**: 415-419.
- Gold, K., 1980. SEM studies on the lorica of various Tintinnina. *Scan. Elect. Micro.*, **3**: 537-541.
- Gold, K. and E. A. Morales, 1975. Seasonal changes in lorica sizes and the species of Tintinnida in the New York Bight. *J. Protozool.*, **22**: 520-528.
- Gold, K. and E. A. Morales, 1976. Studies on the sizes, shapes, and the development of the lorica of agglutinated Tintinnida. *Biol. Bull.*, **150**: 377-392.
- Gold, K. and E. A. Morales, 1977. Studies on the Tintinnida of Enewetak Atoll. *J. Protozool.*, **24**: 580-587.
- Hada, Y., 1932a. Descriptions of two new neritic Tintinnoinea, *Tintinnopsis japonica* and *Tintinnopsis kofoidi* with a brief note on a unicellular organism parasitic on the latter, *Proc. Imp. Acad. Japan*, **8**: 209-212.
- Hada, Y., 1932b. The Tintinnoinea from sea of Okhotsk and its neighborhood. *J. Fac. Sci. Hokkaido Imp. Univ.*, Ser. 4, Zool., **2**: 37-59.
- Hada, Y., 1932c. Report of the biological survey of Mutsu Bay. 24. The pelagic Ciliata, suborder Tintinnoinea. *Sci. Rep. Tohoku Imp. Univ.*, Ser. 4, Biol., **7**: 553-573.
- Hada, Y., 1935. On the pelagic Ciliata, Tintinnoinea, from the East Indies with consideration on the character of the plankton in the seas. *Bull. Jap. Soc. Sci. Fish.*, **4**: 242-252. (In Japanese)
- Hada, Y., 1937. The fauna of Akkeshi Bay. 4. The pelagic Ciliata. *J. Fac. Sci. Hokkaido Imp. Univ.*, Ser. 4, Zool., **5**: 143-216.

- Hada, Y., 1938. Studies on the Tintinnina from the western tropical Pacific. J. Fac. Sci. Hokkaido Imp. Univ., Ser. 6, Zool., 6: 87-190.
- Hada, Y., 1957. The Tintinninea, useful microplankton for judging oceanographical conditions. Inform. Bull. Planktol. Japan, 5: 10-12. (In Japanese)
- Hada, Y. 1964. New species of the Tintinnida found from the inland sea. Bull. Suzugamine Woman's Coll. Natural Sci., 11: 1-4.
- Hedin, M., 1975. Tintinnids on the Swedish west coast. Zoon, 2: 123-133.
- Heinbokel, J. F. and J. R. Beers. 1979. Studies on the functional role of Tintinnids in the southern California Bight. III. Grazing impact of natural assemblages. Mar. Biol. 52: 23-32.
- Jorgensen, E., 1924. Mediterranean Tintinnidae. Rep. Dan. oceanogr. Exped. Mediterr., 2: 1-110.
- Kofoed, C. A. and A. S. Campbell, 1929. A conspectus of the marine and freshwater Cilata belonging to the suborder Tintinninea, with descriptions of new species principally from the Agassiz Expedition to the eastern tropical Pacific 1904-1905. Univ. Calif. Publ. Zool., 34: 1-403.
- Kofoed, C. A. and A. S. Campbell, 1939. Reports on the scientific results of the expedition to the eastern tropical Pacific, in charge of A. Agassiz, by the U.S. Fish. Comm. Steamer "Albatross", from October, 1904, to March, 1905. The Cilata: The Tintinninea. Bull. Mus. Comp. Zool. Harv., 84: 1-473.
- Laval, M., 1972. Ultrastructure de *Petalotricha ampulla* (Fol). Comparaison avec d'autres Tintinnides et avec les autres ordres de Cilies. Protistologica, 8: 369-386.
- Laval-Peuto, M., 1976. Intervention des deux tomites du Tintinnide *Favella ehrenbergii* (Ciliata, Tintinnina) dans l'edification de sa lorica. C. R. Acad. Sci. Paris, 282:2187-2190.
- Laval-Peuto, M., 1977. Reconstruction d'une lorica de forme *Coxiella* par le trophonte nu de *Favella ehrenbergii* (Ciliata, Tintinnina). C. R. Acad. Sci. Paris. 284:547-550.
- Laval-Peuto, M., 1981. Construction of the lorica in Ciliata Tintinnina. In vivo study of *Favella ehrenbergii*: variability of the phenotypes during the cycle, biology, statistics, biometry. Protistologica, 17: 249-272.
- Levine, N. D., J. O. Corliss, F. E. G. Cox, G. Deroux, J. Grain, B. M. Honigberg, G. F. Leedale, A. R. Loeblich III, J. Lom, D. Lynn, E. G. Merinfeld, F. C. Page, G. Poljansky, V. Sprague, J. Vavra, and F. G. Wallace, 1980. A newly revised classification of the protozoa. J. Protozool., 27: 37-58.
- Loeblich, A. R., Jr., and H. Tappan, 1968. Annotated index to genera, subgenera and suprageneric taxa of the ciliate order Tintinnida. J. Protozool., 15: 185-192.
- Marshall, S. M., 1969. Protozoa. Order Tintinnida. Conseil Permanent International pour L'Exploration de la Mer, Zooplankton Sheet, 117-127.
- Meunier, A., 1910. Microplankton des Mers de Barent et de Kara. Duc d'Orleans Campagne Arctique de 1907. (Bulen, Bruxelles), 48: 1-355.
- Paranjape, M. A., 1980. Occurrence and significance of resting cysts in a hyaline Tintinnid, *Helicostomella subulata* (Ehre.), Jorgensen. J. exp. mar. Biol. Ecol., 48: 23-33.
- Sano, A., 1975. Taxonomy of Tintinnida. Mar. Sci., 7: 170-177. (In Japanese)
- Stoecker, D. K. and N. K. Sanders, 1985. Differential grazing by *Acartia tonsa* on a dinoflagellate and a tintinnid. J. Plankton Res., 7: 85-100.
- Tregouboff, G., 1957. Ciliata Oligotricha (Oligotriches Butschli) sous-Ordre des Tintinninea Kofoed et Campbell. In: G. Tregouboff et M. Rose, Manuel de planctonologie Meditteranneenne, vol. 1. Text. Centre National de la Recherche Scientifique, Paris, pp. 160-193.
- Yamaji, I., 1984. Illustrations of the marine plankton of Japan, 3rd ed., Hoikusha Publ. Co., Ltd., pp. 160-193. (In Japanese)

Yoo, K. I. and J. B. Lee, 1986. Taxonomical studies on dinoflagellates in Masan Bay. 1. Genus *Prorocentrum* Ehrenberg. J. Oceanol. Soc. Kor., **21**: 46-55.

Yuki, K., 1984. A check-list of tintinnid Ciliates from the Kuroshio waters adjacent to the Ryukyu Islands, southern Japan. Bull. Inst. Oceanic Res. & Develop., Tokai Univ., **6**: 51-60.

RECEIVED : 12 APRIL, 1988

ACCEPTED : 3 MAY, 1988

## PHOTOGRAPHIC PLATES and EXPLANATION

### Plate I

1. *Leprotintinnus neriticus* (Scanning electron microscopy, SEM), showing spiral structure and arenaceous lorica
2. *L. neriticus* (Light microscopy, LM)
3. *L. nordqvisti* (LM), showing aboral flare
4. *L. simplex* (LM)
5. *Tintinnopsis angustior* (LM)
6. *T. beroidea* (SEM), showing arenaceous lorica
7. *T. butschlii* (SEM), showing oral flare and suboral spiral structure
8. *T. butschlii* (SEM), showing arenaceous lorica
9. *T. corniger* (LM), showing branched aboral horn

### Plate II

1. *Tintinnopsis directa* (LM)
2. *T. gracilis* (LM), showing arenaceous lorica
3. *T. kofoidi* (LM)
4. *T. lohmanni* (LM), showing arenaceous lorica
5. *T. radix* (LM)
6. *T. radix* (SEM)
7. *T. tocantinensis* (LM)
8. *T. tubulosoides* (LM), showing suboral spiral structure
9. *Stenosemella pacifica* (LM), showing oval windows on the hyaline collar

### Plate III

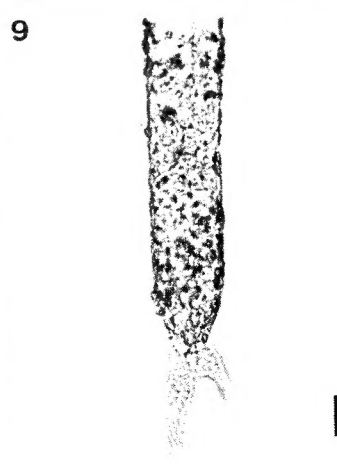
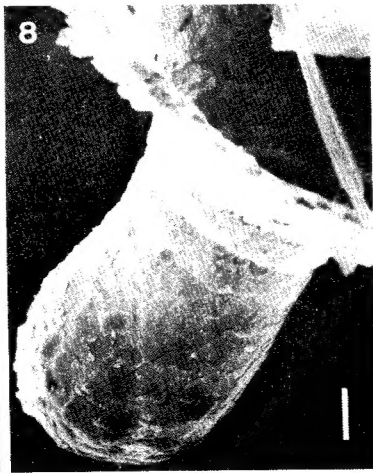
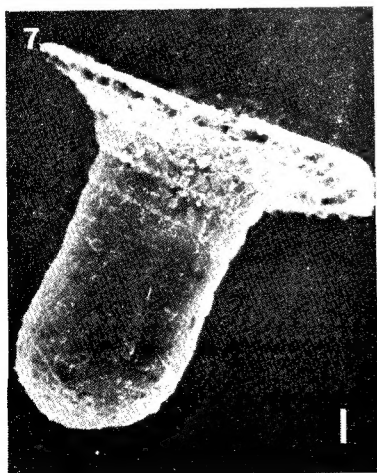
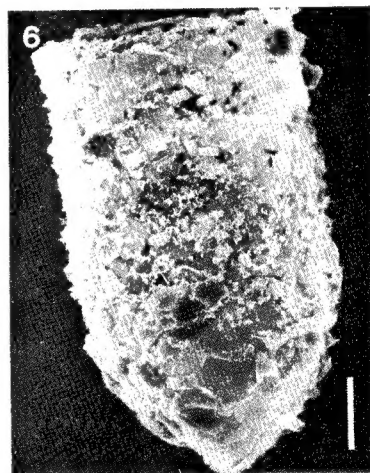
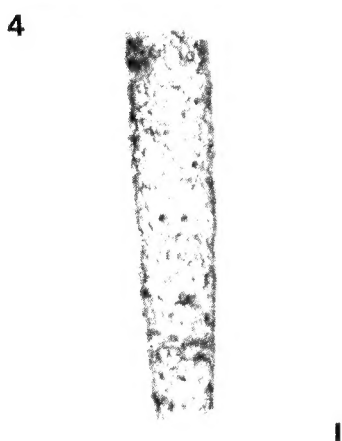
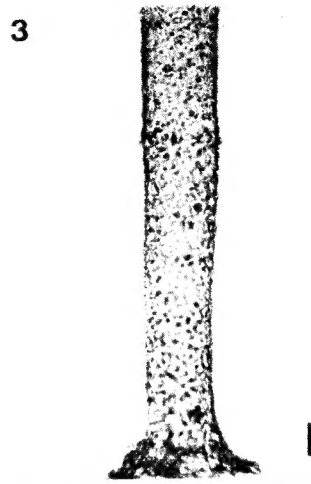
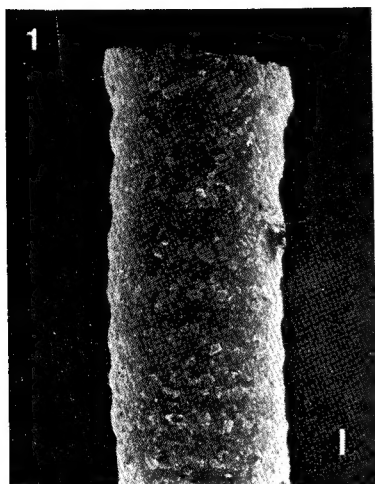
1. *Stenosemella parvicollis* (LM), showing arched windows on the hyaline collar
2. *S. parvicollis* (SEM), showing mostly nonbiogenic fragments and biogenic particles include fragments of diatom frustules
3. *Codonellopsis nipponica* (SEM), showing spiral structure on the hyaline collar
4. *Metacylis corbula* (LM)
5. *Helicostomella longa* (LM)
6. *H. longa* (SEM), showing suboral spiral structure and numerous small grooves on the surface of lorica
7. *H. subulata* (SEM), showing aboral small pore
8. *H. subulata* (SEM), showing oral teeth
9. *Favella azorica* (LM)

### Plate IV

1. *Favella ehrenbergii* (LM)
2. *F. ehrenbergii* (SEM), showing twisted aboral horn
3. *F. taraikaensis* (LM)
4. *F. taraikaensis* (SEM), showing irregular reticulation of lorical wall
5. *Amphorides amphora* (LM with differential interference contrast)
6. *Amphorellopsis acuta* (LM with d.i.c.), showing longitudinal fin
7. *Eutintinus lususundae* (LM)
8. *E. tubulosus* (LM)
9. *Salpingella laminata* (LM)

Scale bar = 10 $\mu$ m

## PLATE 1

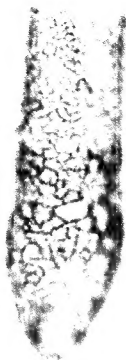


**PLATE 2**

1



2



3



4



5



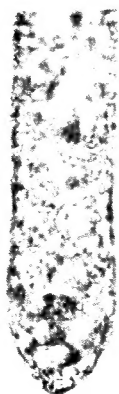
6



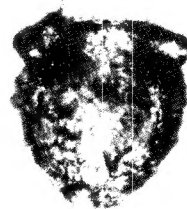
7



8

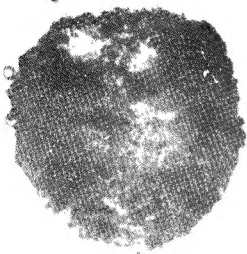


9

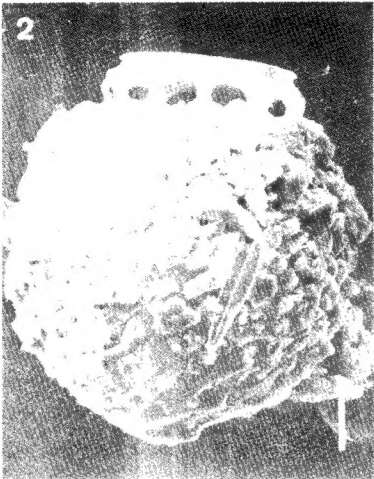


**PLATE 3**

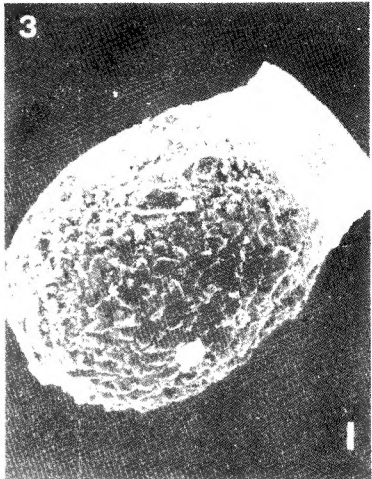
1



2



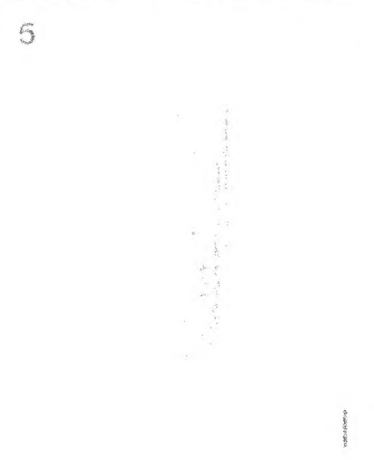
3



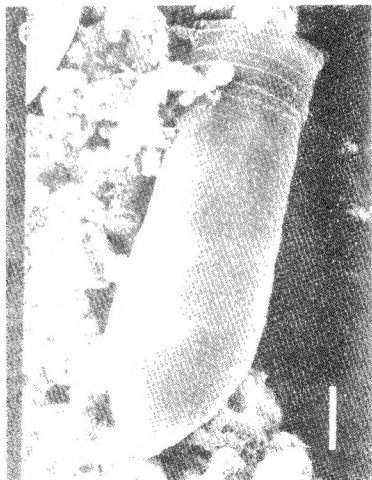
4



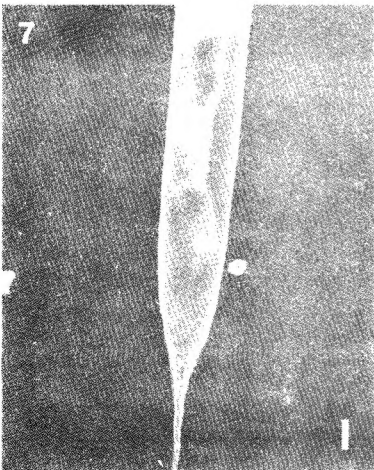
5



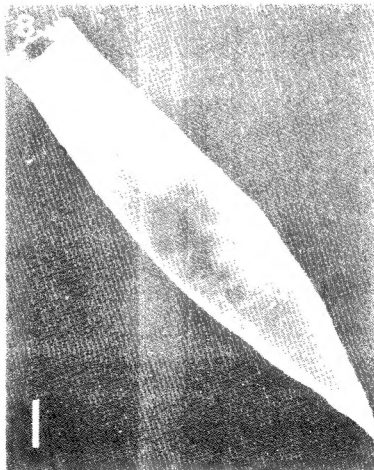
6



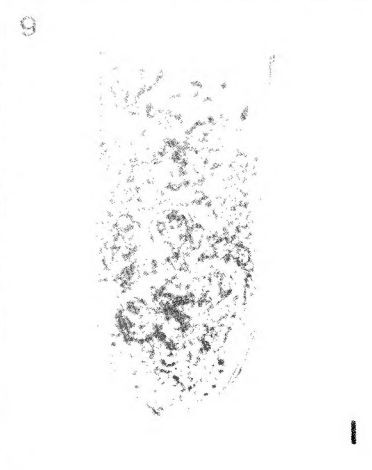
7



8



9



**PLATE 4**